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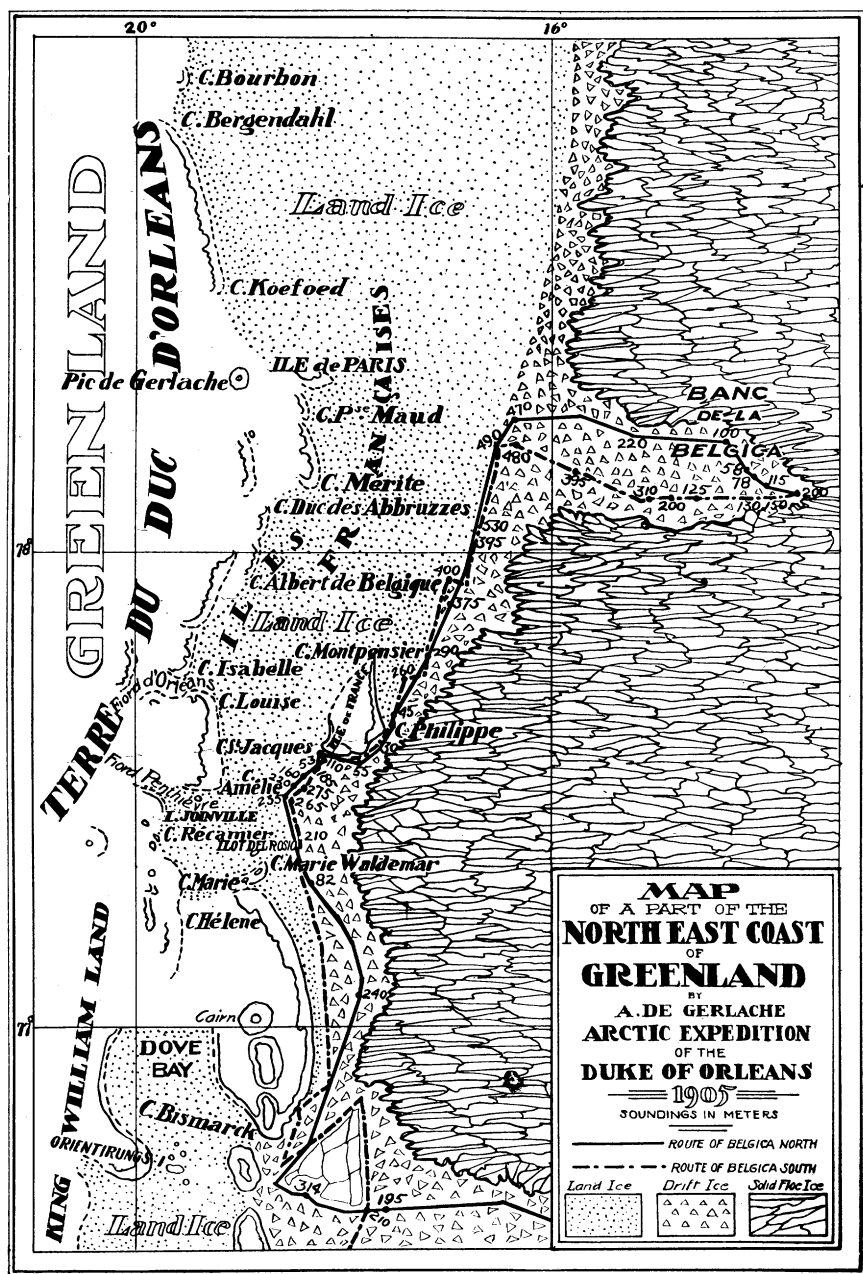
THE NORTH-EAST COAST OF GREENLAND, BEYOND
77° N. LAT.

In the summer of 1905 the Duke of Orleans chartered the Belgian exploring ship *Belgica*, made a cruise in the East Greenland Sea, reached the coast of Greenland in the neighbourhood of Cape Bismarck, the most northern point fixed by the Koldewey expedition, and ascended the unknown coast for about 120 miles (BULL. of the Amer. Geog. Soc., 1905, pp. 672-3). A paper on this exceptional voyage, written by Captain de Gerlache, leader of the Belgian Ant-arctic expedition, who accompanied the Duke, is published in *La Géographie* of the Paris Geographical Society (Vol. XIV, No. 3, September, 1906).

The chief purpose of the Duke's expedition was to make oceanographic studies in the Greenland Sea between Spitzbergen and Greenland. This part of the Arctic Ocean to the north of the 77th parallel was practically unknown, and few precise soundings had been secured away from the coast of Spitzbergen. The *Belgica* was, therefore, provided with the equipment of a modern oceanographical expedition. It was little expected that she would be able to cross the Greenland Sea from Spitzbergen in unusually high latitudes.

The following facts concerning the *Belgica's* voyage are condensed from Captain de Gerlache's paper; and our map is reduced from one of his two maps, published by *La Géographie*.

The *Belgica* left Tromsø for Spitzbergen on June 3, 1905. After spending several weeks along the west and north coasts of this archipelago, a course was taken to the northwest, and on July 9 the



pack ice was reached in 80° 20' N. Lat. and 5° 40' E. Long. The edge of the pack was followed to the southwest, in the hope that an opening might be found through which the ship could reach the Greenland coast in a high latitude. The experience of the whalers in the great days of that industry was that the coast could best be reached through the ice between 72° and 74°; but polar navigation has no absolute law, and the expedition desired to ascertain if the pack could not be traversed at a much higher latitude.

The numerous soundings secured on this southwestern voyage along the edge of the pack ice were the first to be obtained in the central regions of the Greenland Sea in latitudes between 75° and 80° N. A little above the 78th parallel a depth of 2,700 meters was found; nine miles further west the depth was 2,100 meters; 19 miles further west it was only 1,425 meters. About 70 miles south of these soundings, on nearly the same meridian, the depth decreased from 2,600 meters to 1,275 meters in a few hours' steaming. These soundings indicate a submarine ridge extending roughly north and south.

The course was now mainly west not far from the 76th parallel. A little west of 10° W. Long. soundings of 340 meters with gradual shoaling further west showed that the continental shelf had been reached. Here the ship rounded the southern terminus of the impenetrable pack and made its way to the northwest and west.

On July 28, in 77° 5' N. and 17° 50' W. the *Belgica* passed within four miles of the cairn erected in 1870 by Koldewey and Payer on the coast of King William Land. But these explorers attained this northing only after a difficult sledge journey of 150 miles from the winter quarters of their exploring vessel *Germania*. They were twenty-two days on the way north, and the cold was intense. The *Belgica* party, on the contrary, reached the same point in a good ship offering considerable comfort; and the temperature was 2° C. above freezing. The contrast was striking.

From what they saw of the ice conditions Payer had felt justified in saying that "except under unusual circumstances no vessel will ever advance along this coast." The *Belgica* had met these exceptional circumstances. For a time there was no impediment to progress northward, excepting fog. Between the impenetrable pack ice and the land ice, which was still solidly attached to the coast, there was a channel full of floating ice, but still navigable.

No time was lost in starting northward in this channel. The explorers felt their way along through the mist past Cape Bismarck. The fog prevented them from seeing the Greenland coast, but fre-

quent soundings gave them some clew to their distance from it. Then the fog suddenly lifted, and they saw, to the west, the Greenland coast, and in the northeast a large island or a promontory. This discovery was most joyfully welcomed. A party was sent out over the land ice to this new island, from which the *Belgica* was seven or eight miles' distant. They reached the land, which was christened L'île de France, and made a rapid reconnaissance. The island is an old moraine, rising gently to a height of 160 meters. The southern slope, which was easily ascended, was almost bare, while the interior and northern slope were covered with névé. The promontory at the southeast end of the island received the name of Cape Philippe (77° 38' N. and 17° 36' W.).

Although on the rocky surface there was but little soil, the flora was more abundant and varied than that of the islet of Marussia (south of Cape Bismarck), and nineteen phanerogamic plants, seven varieties of moss, four of fungi and six lichens were added to the collections. They found many white hares and in the snow traces of foxes and geese. A lemming was captured. At the highest point of the island a cairn was erected, and a record placed.

Returning down the slope, they found a little worm-eaten structure that puzzled them very much. No trace of a camp could be found, and the rough surface thereabouts was not favourable for erecting tents. The explorers, therefore, came to the conclusion that what they had found was the remains of a fox trap rather than of a human habitation. However this may be, the evidence of the former presence there of Eskimos has its importance, as strengthening the hypothesis that the nomad tribes which reached Greenland from the North American archipelago finally attained the east coast of the island by passing around its northern end.

Around the ship flew terns, petrels and gulls. Now and then a bearded seal (*Phoca barbata*) was seen. During the night numerous narwhals came out from under the winter ice that extended between the Greenland coast and the Ile de France. They swam towards the south in schools of six or seven.

On July 29 the *Belgica* was moored to the land ice near the west point of the island (Cape Saint Jacques). While waiting for the fog to rise so that they might fix the position of this promontory, they took a series of oceanographic observations and secured specimens of plankton. On July 30 the fog was less dense and they could dimly see the island. They weighed anchor in the morning and skirted the coast to determine the orientation of the southern shores of the Ile de France. At 11 o'clock they reached Cape

Philippe. Thick ice extended from the shore. Hugging the outer edge of this ice, they gradually lost sight of the island, and did not know till the fog lifted that they had been following the land ice. Soundings were kept up at intervals of two hours and distances of about six miles. They found depths of 45 meters, then 290, 375, 395. They were getting away from the land and were steering to the N. 15° E.; but about 11 P. M. the wall of ice they had been following since morning turned more to the east and they had to steer to the N. 30° E.

At midnight they reached 78° 16' N. and 16° 48' W. They were then 167 miles to the north of the extreme point previously attained on that coast by an exploring vessel (*Germania*, 75° 29' N., July 27, 1869). It was about the highest point they could reach. The fog, lifting for a moment, enabled them to gaze over the sea. It was covered with heavy ice. They could not push much further towards the north. Undoubtedly, they might have added some minutes of latitude to their record, but they could not run the risk of being caught in the ice, for they were not prepared to spend the winter in the Arctic. They desired, however, to utilize their exceptional position by taking a few soundings further east.

At midnight on July 31 the lead showed 470 meters. At 4 o'clock the next morning, fifteen miles further east, the sounding was only 220 meters. Three hours later bottom was found at 100 meters. Things were becoming interesting. The ice was growing more compact and the *Belgica's* prow had to be turned to the southeast. At 11 A. M., about 30 miles east of the midnight position, the depth was only 58 meters, and pebbles were brought up. They had discovered a morainic bank, which they named the Belgica Bank. They thought they might be in the neighbourhood of an island, for they saw two ravens and a walrus, and these animals are never found far from land. The explorers were eager to elucidate this interesting problem, but circumstances compelled them to leave it to others. The fog lowered again; to the north and east the ice had become almost impassable, and nothing more could be done there except to take a few soundings in the east-south-east. In this direction the ice was a little more practicable, yet it formed such a maze of channels that in the fog it was difficult to find a way through. The soundings showed 75 meters, then 115 and 200 meters. An observation of a horary angle enabled them to fix the longitude of the last sounding at 13° 36' W. The latitude was estimated at 78° 7' N. They were forty miles east of the coast of Greenland, in the midst of the great white space left on the map by earlier explorers.

The pack was becoming more and more unmanageable, and it was decided to regain the Ile de France, in order to fix its position a little more precisely. The explorers sounded frequently during the rest of the day. At 11 P. M. the fog lifted a little and they saw to the west the reflection of the land ice and of the land projected on the sky in two strata, the "iceblink," all white, and the "land-blink," a yellowish white; then the fog veil became still thinner, and very elevated land appeared in the distance. Seaward the cloud banks hung low on the ice, and their hope of seeing the land, whose existence had been suspected, was disappointed.

On August 1 the pack was rather more navigable, and the route was slightly inclined to the north, in order to catch a glimpse of the most northern land to be seen from their position. At 4 o'clock they reached the ice wall they had skirted the day before. It was the edge of the land ice, and they made fast to it to take the bearings of land that was in view. The land ice formed a solid field covered with soft snow, in which they sunk to their knees. The ice stood from $1\frac{1}{2}$ to 2 meters above the sea and its edge extended about N., 15° E. The edge was nicked with breaks and cracks made by the floating ice brought down by the polar current. There was little evidence that pieces of the land ice are detached from the mass by thawing. The mass had every appearance of stability. To the south of Ile de France, however, the land ice had a very different aspect. It emerged above the sea only thirty to forty centimeters. Ravages had been made by melting, and the uneven surface enclosed great pools of water. Large pieces detached from the land ice moved off to mingle with the polar pack.

During the morning the floating ice moved along the edge of the land ice, carried to the northward by a current of 275 meters an hour. In the afternoon, however, the drift was towards the south at a rate of movement only one-third as great. The *régime* of flux and reflux currents was recognized here, one of them nullifying and even more than counteracting the polar current and the other accelerating its rate of movement.

At 2.30 A. M. on August 2 the lower part of the land appeared; then, little by little, the fog veil was completely lifted. They saw before them an immense panorama of the Greenland coast, stretching from 80 to 90 miles. Mérite took advantage of this opportunity to catch a detailed view of the coast, while Bergendahl and de Gerlache took a series of bearings. At 5 o'clock the *Belgica* cast off and proceeded south along the land ice.

The day was radiant, and at 4 P. M. the thermometer marked

3.8° C. The men were quite warm. After doubling Cape Philippe, the vessel was moored at the edge of the land ice near Cape Saint-Jacques. Next day, in fine weather, the position of Cape Saint-Jacques was determined—77° 36' N., 18° 10' W. A round of angles was also taken from this point.

On the beach, near the point of observation, they discovered one of those circles of stones carefully placed together, in which earlier explorers thought they recognized "tent circles." The Eskimos have a habit of securing their tents by placing stones in a circle around them. It seemed to the Duke of Orleans and his comrades, however, that when the Eskimos struck camp and folded their tents, they would not be careful to leave exactly in a circle the stones that had held their tents to the ground. In their opinion these circles did duty rather as the foundations of snow huts. They discovered no other evidence of the existence here of Eskimos. They found, however, on Cape Saint-Jacques a musk-ox skull and a bit of drift wood. They saw also ravens, a skua and a sea woodcock (*becasseau de mer*).

In the morning a strong south current carried the floating ice against the edge of the land ice, and before the explorers could cast off their hawsers the *Belgica* was completely closed in. The rudder was considerably damaged and, for several hours, the expedition was in an unpleasant situation. In the afternoon, however, with the aid of the wind, they were able to get out of the ice and continue the voyage south.

On August 4, they made fast to the edge of the land ice, and the Duke of Orleans and Dr. Récamier, with a few of the men, started west for a trip over the ice to Cape Amélie. The ice was rapidly breaking up, but, in spite of many obstacles, they nearly approached their destination when they found that the land ice was detached from the coast, and, as they had no boat, they were forced to beat a retreat. The party returned after twelve hours, greatly fatigued by their difficult march over the spongy ice. Though they missed the satisfaction of planting their flag upon this point of the Greenland coast, they gained at least the impression that Cape Bismarck is not a promontory of the mainland, but is the southern point of a large island. On this day numerous narwhals passed the ship in schools of five or six, swimming south in the morning and north in the afternoon; or, in other words, against the current each way.

The accompanying map, showing the part of the coast of East Greenland between 77° and 79° N., was the result of a very rapid

reconnaissance carried out under unfavourable conditions: "We show on this map what we saw and probably not all that is really there." Cape Bourbon, which seemed to be an island, was observed only from one point, and that was from the masthead. Only one azimuth was available to fix the position of Cape Bergendahl. All the other salient points of the map were the result of two or more compass bearings. Noteworthy points mapped as capes may be promontories, or perhaps they are simply elevated areas behind the coast, and they alone came into view. Are the white spaces which separate them fiords or wide valleys? The *Belgica* explorers express no opinion on many such questions. As far as they could conjecture, both from what they saw and from what is known of the coast regions to the south of 77° N., the part of the East Greenland shore between 77° and 79° N. is penetrated by deep fiords, many of which doubtless communicate with one another in the interior. The lands are covered with an immense sheet of ice (the inland ice), above which black rock escarpments are sometimes seen. Glaciers may, perhaps, be found in the ravines; but the explorers saw no evidence that glaciers descend to the sea, except in the case of the local glacier, which moves down the southeast slope of the Ile de France. No true iceberg was seen in the Greenland Sea.

It was impossible to give careful attention to tidal movements along the coast, though while the ship was moored to the land ice there was conclusive evidence that the currents to the north of Cape Bismarck alternate, one of them flowing to the north and the other more rapidly to the south. To the south of the Ile de France, where the waters are not affected by the great polar stream, the alternating currents appeared, other things being equal, of the same intensity, and they are evidently the tidal currents.

The coast ice to the south of the Ile de France differs from that to the north. In the south it is annual or, in other words, it forms every winter, while in summer part of it disappears by melting and a part drifts away in large floes. In the north it seems to be always attached to the coast and to be reduced chiefly by the grinding action of the floating ice. Along the edge of this land ice, both to the north and to the south of the Ile de France, was a channel sufficiently free from ice for navigation.

On August 5 a landing party reached the land a mile north of Cape Bismarck, where the ruins of an Eskimo village were found. They consisted of a dozen stone circles and three graves. The shore was barren, but a little above it was vegetation in considerable variety, and a little inland there were even pastures. The explorers

were surprised to find no sign of the musk ox here. They saw, however, many traces of the hare and lemming, also of snow buntings, terns, and sandpipers. Next day they landed again at the southern point of the largest of the Koldewey Islands (Cape Arendts), a low point of morainic origin, which extends seven or eight miles further south than is shown on the German map. The channel between the islands and the Greenland coast was still entirely covered with winter ice. Floating ice massed compactly to the north and east of Shannon Island compelled the Duke of Orleans to forego his intention of visiting this island, and also prevented a near approach to Franz Josef fiord. The season was now far advanced, the nights were cold, and sometimes the sea was covered with young ice. It was time to reach the open sea.

On August 12 the sun disappeared for a few minutes below the horizon. The *Belgica* was steaming south in pack ice that now was easily navigated and then was quite compact. Everything was enveloped in dense fog.

On August 15 the *Belgica* steamed east, and on the 17th in 70° 38' N. and 15° 22' W. she felt the ocean swell. The wind was fresh from the southeast, and the ice was massed in wide belts. The fog hid the surface of the pack and the channels through the ice. At 2 P. M. on the 18th the ship reached a compact belt of ice, which was thrown into long undulations by the swell. At 8 o'clock that evening the open sea was reached, and four days later the *Belgica* anchored in the harbour of Reykjavik.

During six weeks in the Greenland Sea there were 482 hours of fog; that is to say, in the proportion of one day to two. The maximum frequency of fog occurred while crossing the pack from July 21 to 27 and from August 15 to 18. Really fine weather was exceptional. From July 22 to August 8 the temperature was above zero (C.), though frequently near the freezing point. The lowest temperature was -3.4°C . on July 16 at 4 A. M., and on August 9 at 2 A. M.; the highest temperatures were $+7.2^{\circ}\text{C}$. on July 27 at 2 P. M. and $+7.1^{\circ}$ on August 7. The humidity was generally near the point of saturation. Very frequently the weather was perfectly calm, and the force of the wind was usually less than ten meters a second.

The ice pack in the summer of 1905 certainly presented very favourable conditions for navigation. The experience of the *Belgica* is corroborated by that of the Norwegian sealers. In May and June they found the edge of the pack ice more to the east than usual, and, being spread out more, the ice was less compact than in earlier

years. About the end of May the yacht *Excelsior*, from Tromsø, found the pack ice very scattered and penetrated 120 miles into it to 75° 30' N. Two other vessels, the *Söstrene* and the *Severin*, crossed the pack and reached land early in July near Shannon Island. They found an ice-free channel along the coast, three to four miles wide, which they followed northward almost to Cape Bismarck, which no ship had reached before. The *Belgica* crossed the pack at a higher latitude than any ship before it had done. It was not easy, however, to keep the ship going in these latitudes; and if it had not been for the wish of the explorers to add new soundings to the map, they would have chosen an easier route from 50 to 100 miles further south. On the other hand, after they had made Cape Bismarck, no serious obstacle impeded their northern voyage to 78° 16' N.

Eighty soundings were made, many of them in an unexplored zone; in fifty soundings temperatures and specimens of water were obtained at different depths; plankton was also secured at various depths at several of the stations. East Greenland was for the first time connected with Spitzbergen by a complete series of oceanographical observations. These observations have been co-ordinated in the Bergen laboratory with those of the same kind made by the International Commission for the Exploration of the Sea.

The meteorological observations which were made every two hours during the entire cruise were sent to the Copenhagen Meteorological Institute for comparison with those taken at the Danish stations in Iceland and Greenland. Captain de Gerlache says that Mr. Mylius Erichsen, who is now supposed to be with his expedition on the east coast of Greenland, will doubtless modify to an important extent the hasty reconnaissance of the *Belgica* party. The work of the *Belgica*, however, supplied useful information to Mr. Erichsen and proved the feasibility of his plans.

The technical results of the cruise will be brought out by the Duke of Orleans in a handsome publication early in 1907.